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## Reflections on developing a tool for creating visual representations of learning designs: towards a visual language for learning designs

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ANDREW BRASHER, SIMON CROSS

## **12. REFLECTIONS ON DEVELOPING A TOOL FOR CREATING VISUAL REPRESENTATIONS OF LEARNING DESIGNS**

*Towards a visual language for learning designs*

### **ABSTRACT**

Over the past four years we have been developing CompendiumLD, a software tool for designing learning activities using a flexible visual interface. It has been developed as a tool to support lecturers, teachers and others involved in education to help them articulate their ideas and map out a design or learning sequence. CompendiumLD is a specialised version of Compendium, a tool for managing connections between information and ideas, which has been applied in many domains including the mapping of discussions and arguments. As most of the core knowledge mapping facilities provided by Compendium are included within CompendiumLD, it can be used for learning design, and applied it to other information mapping and modelling problems. Evidence gathered since CompendiumLD's first release has shown the many conditions in which it is likely to be applied and appreciated by users, and that the need for visualising learning designs as a solution to understanding how all components of planned learning and teaching fit together may continue to grow. Furthermore, the use of technology is making the process of creating courses more complex. We explore these challenges and conclude with some reflections on the developments in visual representation needed to further facilitate the modelling of today and tomorrow's complex learning situations.

### **INTRODUCTION**

CompendiumLD is a software tool for designing learning activities using a flexible visual interface. It has been developed as a tool to support lecturers, teachers and others involved in education to help them articulate their ideas and map out a design or learning sequence. This development has spanned 4 years, and the development process we have engaged in has served as a vehicle through which we have been able to better understand how educators relate to and use visual representations of learning designs.

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In this chapter we describe how evidence gathered since CompendiumLD's first release has shown the many conditions in which it is likely to be applied and appreciated by users. Early staff surveys revealed a clear need for visualising learning designs with over half of the Open University staff who responded agreeing that it is becoming harder to understand how all the components of planned learning and teaching fit together. Furthermore, the use of technology is making the process of creating courses more complex. We explore these challenges and conclude with some reflections on the developments in visual representation needed to further facilitate the modelling of today and tomorrow's complex learning situations.

CompendiumLD comes with predefined sets of icons, some generic and some specific to learning design. The learning design icons enable the user to visually represent activity designs that concur with Beetham's definition of a learning activity:

a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes

(Beetham, 2007, p. 28). These icons may be dragged and dropped, then connected to form a map that represents the interactions between tools, people, resources, outcomes and so on within a learning activity.

CompendiumLD is a specialised version of Compendium, a software tool for knowledge mapping, i.e. managing connections between information and ideas that has been applied in many domains including the mapping of debates, discussions and arguments (Buckingham Shum & Okada, 2008). Compendium provides a default set of icons for creating maps to visualise the connections between ideas and information. Most of the core knowledge mapping facilities provided by Compendium are included within CompendiumLD. This means that users can use CompendiumLD for a variety of styles of learning design and apply it to other information mapping and modelling problems. Figure 1 shows three of the design views that CompendiumLD provides.

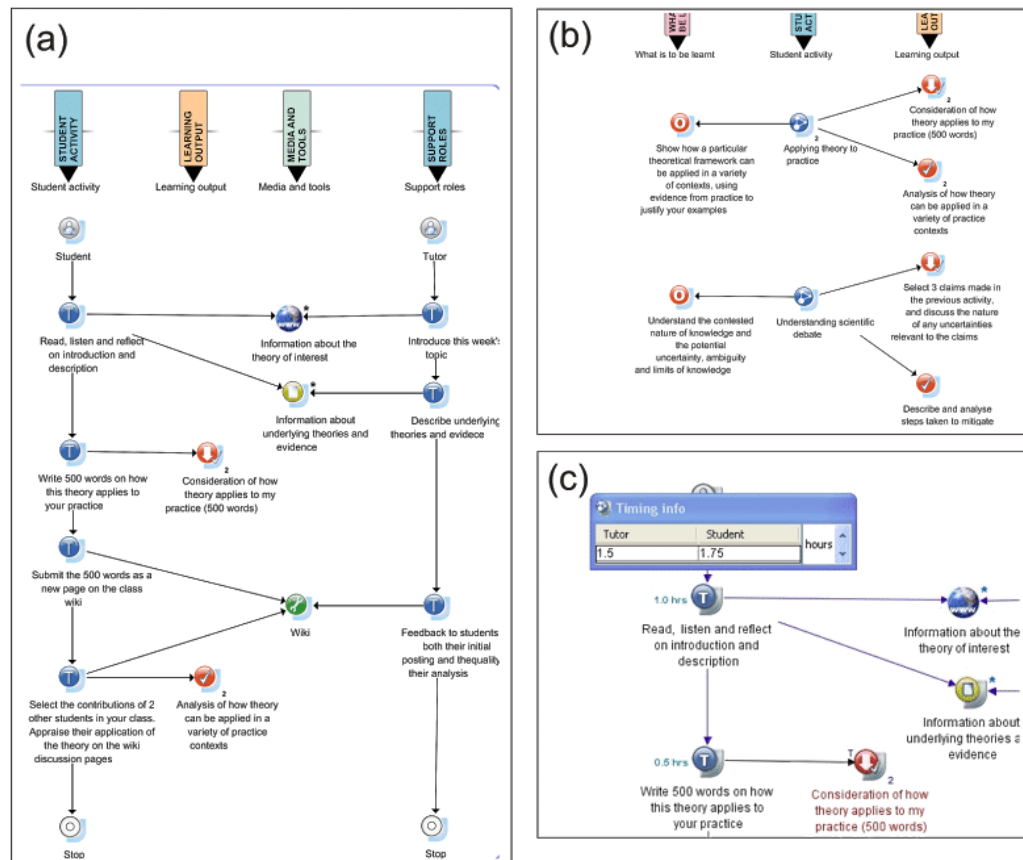


Figure 1. A variety of design representations created using CompendiumLD: (a) Learning sequence map (b) Learning outcomes view (c) Sequence map showing task times

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CompendiumLD's development has occurred within the Open University Learning Design Initiative (OULDI), a project funded by the Open University and JISC (JISC/Open University, 2009).

#### RATIONALE FOR DEVELOPMENT

The decision to develop CompendiumLD was informed by claims that the advent of e-learning is making the process of creating course modules more complex, that staff are feeling more overwhelmed by the challenge of how to effectively integrate ICT in a course (Agostinho, 2008), and that staff find it is becoming harder to understand how all the parts or components of planned learning and teaching fit together (Falconer & Littlejohn, 2007). A survey of OU staff found over half agreed or agreed somewhat with these three claims (n=50). 47% of respondents were Teaching staff (as classified by primary role job titles such as lecturer), and 53% were Non-Teaching staff involved in production of teaching and learning materials (e.g. teaching and learning staff, media developers, managers, editors) (Cross, Clark, & Brasher, 2009).

Compendium was selected as the basis for our tool as it offered significant and sophisticated functionality, which could be relatively easily adapted and modified for our purposes. The inherent philosophy underpinning Compendium, in terms of providing visual representation to support the development of thinking and shared argumentation also fitted our criteria for selection, as it aligned well with our requirement to develop a tool that would support user thinking specifically for the design process (Brasher et al., 2008).

CompendiumLD was designed to allow users to model complex relationships between different aspects of a learning and teaching process, to do this in a relatively flexible and unconstrained way, and to allow individuals and teams to think ideas through before committing to implementation. The CompendiumLD concept is predicated on the belief that creating a visual representation of learning design can add value to the process of design and teaching. This is supported by studies of both experts and novices (albeit in fields other than learning design) showing that use of visual problem representations facilitates thinking and problem solving performance (Moreno, Ozogul, & Reisslein, 2011). It also builds on suggestions that the variation in degrees of success in problem solving (in this case, the solving of a learning design problem) among problem solvers might be attributed more to the meaningful representation of knowledge than to the amount of the designers prior knowledge (Lee, 2004).

At the time of CompendiumLD's initial development there were a variety of other learning design tools available for use and/or under development. For example, Phoebe (The Phoebe project, 2006) aims to support users through a structured text based learning design process. Tools such as Reload (Reload, 2005) enable users to create runnable learning designs by creating IMS-LD (IMS, 2005) output. The London Pedagogy Planner (San Diego et al., 2008) aimed to support its

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users through making pedagogically informed design decisions through a variety of textual and visual representations. LAMS (Lams Foundation, 2009) provided an interactive online environment for both designing and delivering online learning that is focused on collaborative learning activities. The purpose of CompendiumLD contrasts with these tools in that our aims was to provide a tool that would allow users to approach the design process irrespective of the pedagogy, technologies or structures to be used in the learning design (cf. LAMS), and that would provide an easy way into experimenting with design ideas through a focus on visual representation (cf. London Pedagogy Planner, Phoebe) at levels of abstraction chosen by the user. An intentional key difference between CompendiumLD and the IMS\_LD based editors available at the time (cf. Reload) was the primary function of the software. The focus of IMS\_LD based tools was on being able to run the designs, meaning users needed to make detailed design decisions necessary for executing the unit of learning in order to be compliant with IMS-LD. In contrast the intention was for CompendiumLD to allow a free form type of model development during which users could focus their attention on pedagogical design issues.

## ITERATIVE DEVELOPMENT AND USE

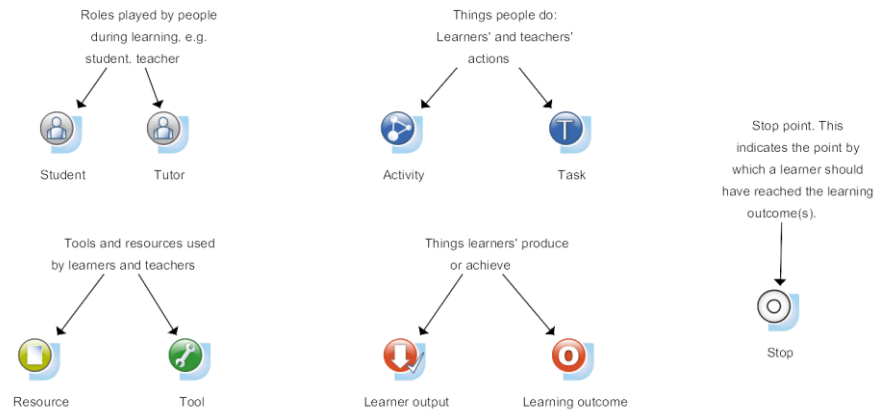
### *Development*

CompendiumLD has been developed iteratively since 2008, and 7 versions have been released since March 2009 (The Open University, 2012). Its initial development was informed by data on course design teams' practices collected at the Open University through interviews and observations during 2008 and 2009. This data showed that the learning design process is complex, creative and interactive one, and that even when collaborating within a team there is a large element of individuality within the process. Individual academics work at different levels of granularity and focus on different aspects of design over the curriculum design lifecycle, as do others in the design team e.g. software developers (Conole et al., 2008).

The earliest stage of prototyping involved adding some learning design icons to Compendium (Conole & Weller, 2007), without altering Compendium's functionality. The node-link form of representation provided by Compendium was (and is) considered useful for representing learning designs because of its flexibility. The ability to create complex networks of linked nodes meant that a great variety of arrangements and relationships between different concepts can be made; the user is not restricted to one particular form, e.g. a mind map emanating from one central node. The first version of CompendiumLD included a learning design icon set created by a graphic designer. Subsequent versions of CompendiumLD included refinements and additions to the initial icon set informed by the interview and observation data described above, consideration of Beetham's definition of a learning activity, heuristic exploration and application of Bertin's notions concerning visual variables such as size, shape and colour (Bertin,

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1983). This resulted in the CompendiumLD core learning design icon set, in which icons for related purposes share similar visual characteristics. The related purposes include the depiction of roles, actions (tasks and activities), tools and resources, student achievements, and process flow as shown in Figure 2.



*Figure 2. CompendiumLD core learning design icon set showing icons showing icon groups related by purpose*

These early versions of CompendiumLD also featured addition of functionality specific to learning design also informed by the interview and observation data described above. These include prompts, context sensitive help, and other learning design icon sets in addition to the core set shown in figure 1 (Brasher, et al., 2008).

Since CompendiumLD's first public release in March 2009 several types of developmental testing and evaluation have been carried out which have contributed to the focus and direction of development of the tool. Early testing and feedback was sought through surveys of media developers, editors and project managers (in March and June 2009), and evaluation by a novice user following a semi-structured script (in November 2009) (Brasher, 2012). Later, analysis of forum comments from students about their experience of use of CompendiumLD (2010 and later) were taken into account (Brasher, 2010), and these were complemented by a less formal series of observations of use of CompendiumLD in workshops run by the OULDI team during the JISC project between 2008 and 2012. Overall, the testing and evaluation resulted in key changes to the tools functionality for saving and sharing learning designs, for copying, cutting and pasting design elements, to revisions and additions to the icon sets, and to the documentation and help resources provided.

For example, the survey of media developers, editors and project managers identified the main potential benefits were in supporting communication, creativity, clarification ('...of potential complex problems') and use in production processes and planning (such as future specifications, helping picture research, preparing drafts, and identifying gaps). As one participant said:

I think that it would be useful for course teams to use devices like CompendiumLD when planning their courses. It would be good to have a visual representation of what the course was going to do, and how it was going to do it, at an early stage in course production. This would help to ensure that everyone involved was clear of the production plan, and would be able to understand their role accordingly (Cross, Galley, Brasher, & Weller, 2012)

This quote hints that one key perceived benefit of design visualisation in general or CompendiumLD in particular, could be to the overall design process (the communication of designs rather than sole use by a particular individual). Indeed, the last phase of our CompendiumLD development has focused on building functionality to embed SVG images (design maps) in to web pages to facilitate sharing (Brasher, 2012).

#### *Feedback and use*

CompendiumLD has been downloaded over 2,000 times since its release in 2008, and there have been several thousand visits to the online documentation, slide shows and screen casts provided to help users get started with the tool. For example, the 'getting started' screen cast has been viewed over 4000 times and downloaded 50 times since 2010 and two other presentations about CompendiumLD have been viewed more than 2000 times each (Brasher, 2012). This indicates continued interest in the CompendiumLD tool.

The principle source of data about the user experience, however, is the evaluation undertaken for the JISC funded Open University Learning Design Initiative. The CompendiumLD tool and visualisation approach comprised one of range of tools and approaches trialled by the project over twelve pilots across six universities. The research used a mixed methods research approach that included post-pilot questionnaires (over 200 responses), stakeholder interviews, over 20 personal narratives and case studies, user testing, and field notes and reflective logs from over two dozen workshops (Cross, et al., 2012; Open University Learning Design Initiative, 2012a, 2012b). In particular, the personal narrative case studies reveal valuable insight in to individual and groups' reactions to using CompendiumLD and the visual representations created using it.

The benefit of having visual, rather than textual, representations was often noted by participants in the pilots and associated workshops. One participant from Brunel University noted

this is a really good visualisation of a module. It's interesting to see this representation as opposed to the textual ones that we [usually] use.

The evidence indicates that CompendiumLD and the visual approach it represents may prove particularly useful support for those with some prior skills in visualisation. An academic from London South Bank University who was familiar with visualisation techniques



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picked up the concept and ‘ran’ with it... see[ing] the value in the methodology (Brown, 2012),

whilst an academic from Reading University, also familiar with visualisation in the form of concept, concurs and noted

it makes you think about the different components of the learning process in a way that is structured, and it makes people address these issues and discuss them.’

Furthermore, also in the Reading pilot, a participant thought the

‘thoroughness... was aided and abetted by the software process – the tool in use ... -my view is that its revolutionised our thinking [about] learning and teaching (Papaefthimiou, 2012),

and more broadly, it was noted that:

CompendiumLD really helped with visualisation and making the process of curriculum design explicit, bringing sophistication to the course design practices already embedded in the School (Papaefthimiou, 2012).

The concept mapping approach used by CompendiumLD was certainly appreciated by some users in helping them build understandings of relationships between module elements. As one user from the University of Hertfordshire explained:

The mind-map structure is open and invites a creative response to the design, but some designers may find this lack of structure limiting. There are some stencils, or sample templates to use to guide the planning. The separate components of the design, tasks, resources etc, are indicated by icons that can be moved around the screen and linked together. This allows for easy exploration and revision of the design. The output is a mind-map of the design that is clearer and could be shared with colleagues for annotation and editing (Posting on Cloudworks, member of staff from University of Hertfordshire)

It was also useful to help understand the complexity of a design. As one participant from the Reading University pilot noted:

[I got benefit from] visualising module or course design through CompendiumLD and’ [there was a] very good focus for developing a complex case study based module using Compendium[LD] as a vehicle for refining design and delivering strategy’ (Papaefthimiou, 2012).

Many staff, however, faced challenges in both visualising a module and using computer software to undertake this visualisation, often because they were unfamiliar with the approach or lacked skills in using visualisation software (such as concept or mind mapping). Indeed, one participant interviewed after the Brunel University pilot explained:

Staff have generally not visualised their designs in the past, apart from possibly flipchart or pencil and paper efforts at times (due to the traditional

nature of face to face teaching). They were introduced to CompendiumLD for the first time. The opportunity to reflect on the design of their programmes, their personal design practice, and the range and balance of topics ... were generally commended (Alberts, Sharma, & Parnis, 2012).

Feedback suggested that for some 'getting their head around' CompendiumLD, and the representations it enables users to create, can be a significant change and challenge. The fact that many staff did not appear to have or be keen to learn visual techniques to map, understand and design was a consistent observation across the pilots (Cross, et al., 2012). Reservations included remarks that using CompendiumLD took too much effort, and that it would require formal training to achieve beneficial results (De Baets & Sheppard, 2011).

Outside the OULDI project there are several other examples of use that we have become aware of. For example, CompendiumLD has been used in the Master of Science in Learning and Teaching Technologies course offered by the University of Geneva during 2012, 2011 and 2010. Examples of the activities that students have to undertake are available on the university's edutech wiki (see e.g. Université de Genève, 2012) and designs produced by students of the course are also available via the same wiki<sup>1</sup>. A comment from a student at the University of Geneva shows that whilst initially, the 'blank canvas' of the mind map was daunting for some, this can be overcome:

I met some difficulties in modelling the learning scenario in CompendiumLD: ... what information must be presented on the map? [Then] I discovered the ... sequence mapping icons. These are a great way to guide the implementation of the concept map! Finally, I realised that a concept map, well-built and well-reasoned a priori, [can be] used to implement the [LAMS] activity in a very easy way (Cereghetti, 2012), (translated from the French original).

Other evidence of use outside the OULDI project includes the appearance online of Spanish translations of CompendiumLD documentation (e.g. <http://www.slideshare.net/sirear/tutorial-compendio-ld>, <http://www.slideshare.net/sirear/nodos-e-iconos-de-compendiumld>). Also, CompendiumLD was used for the design of Elluminate tutorials in the ATELIER-D project (Jones & Holden, 2011).

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<sup>1</sup> This search produces examples of students' work i.e. their 'rapports'  
<https://www.google.com/search?hl=en&lr=&noj=1&biw=1024&bih=637&q=compendiumld+rapport+11+site%3Aunige.ch&oq=compendiumld+rapport+11+site%3Aunige.ch>

## DISCUSSION

Whilst favourably received by many teaching and learning specialists, and those with a professional interest in teaching and learning, CompendiumLD has not yet achieve widespread use. It remains considered by many academic staff as a specialist design tool, or one that has yet to convince that the time investment required will yield return – put another way, that the problems or errors in a design that such visualisation can help reveal are not considered worth the additional effort by academic members of staff.

However, evidence gathered from users since CompendiumLD's first release in 2008 has suggested the conditions in which it is likely to be applied and appreciated by users. These can be summarised as characteristics of the problem to which it is applied, and the characteristics of the user(s) making use of it, i.e.

- users are comfortable with a visual approach
- the design problem features many design choices (e.g. a free choice of tools, resources, teaching approach etc.) .

With respect to the former, one method to better engage those unfamiliar with visualisation was trialled during the second OULDI workshop at London Southbank University (LSBU). Here participants were asked to do the same visualisation task (build a sequence map) as at other workshops, but this time using paper with stickers of the CompendiumLD icons rather than using a computer running CompendiumLD. The LSBU report notes that

most academics are less skilled in this area; for them sticking to paper-based tools in a face-to-face situation has proved a better option (Brown, 2012).

We have not yet tried this approach more generally, and other means of bridging the gap between paper and computer-based visualisations remain to be explored. The latter characteristic requires potential users to be able to identify appropriate design problems from within the mix of learning design problems they are faced with. Whilst we did experiment with context-sensitive help for the design being worked on within CompendiumLD we have not yet provided any guidance for users to point them towards the type of problem that CompendiumLD has been seen to be of benefit for, so this remains on our 'to do' list. (We did not see Context-sensitive help as a priority because of an unenthusiastic response to initial prototypes, the need to focus developer resources, and the availability of Cloudworks as an alternative source of guidance (Brasher, 2012)). Given that staff are feeling more overwhelmed by the challenge of how to effectively integrate ICT in a course (Agostinho, 2008), and that they find it is becoming harder to understand how all the parts or components of planned learning and teaching fit together (Falconer & Littlejohn, 2007), we feel the role of visual representation as an aid to design is worth exploring further, be it through CompendiumLD or alternative routes. To that end, we put forward some ideas for visual developments the next section.

*Looking to the future - some ideas for visual developments*

Earlier in this chapter we stated that we had considered Bertin's ideas about visual variables during the iterative development of CompendiumLD. Bertin drew on a background in cartography to develop his theories, and they have been widely applied to visualisation problems in many domains (see e.g. Card, Mackinlay, & Shneiderman, 1999). We now consider whether Bertin's ideas could provide additional benefits in the application of visual representation to learning design.

The approach taken by Bertin is to consider the concepts to be represented (e.g. task, role, tool etc.), then to identify the dimensions of each concept that are important for the particular application, and to consider how each dimension is organised. Dimensions can be organised in 3 ways: they can be qualitative, ordered or quantitative. Occurrences of qualitative concepts are reorderable, i.e. there is no implicit ordinal relationship among them. For example in our CompendiumLD representations, we consider the tool concept within a learning activity to be a qualitative concept, and the 'levels' along the tool dimension are the available tool types (wiki, blog etc). These tool levels are represented by a textual label. We also represent the output that a learner produces as a qualitative variable, named in terms of the way that the output is assessed within the design (formative, summative etc.). To date we have used mainly the visual variable of colour to discriminate the component parts of a learning activity, whilst also indicating relationships in purpose, as shown in figure 2. Indeed, in our current representation of a learning activity all of the concepts that make up an activity are qualitative, except the task concept. For a task or activity, there are two dimensions that are quantitative: its duration, and its position in a sequence. Ordered concepts are those that can be sorted in that they have 'greater than' and 'less than' relationships to each other, but do not have a numerical value. For example the descriptors 'small', 'medium' and 'large' are ordered. Could or should any of the other concepts in our learning design vocabulary be ordered, quantitative, or have other qualitative aspects represented visually, so as to help users design?

For example, to drive a design forward based on the nature of the intended outcomes, we could add dimensions to the representation of a learning outcome. Instead of the single learning outcome icon we currently use to represent any and every learning outcome, we could represent the type of learning outcome e.g. knowledge and understanding, cognitive skills, professional/practical skills (Centre for Outcomes-Based Education, 2007), through addition of either a textual or coloured tag. An outcome classified in this way could be used by the software to facilitate steps in the design process as illustrated in the following scenario. When the designer comes to map out the detail of a learning activity that is intended to deliver a particular learning outcome they will have to make various decisions, including specifying the tasks and tools that learners will utilise to reach the outcome. For a learning outcome classified as (for example) a 'cognitive skills' outcome, the designer could begin by specifying a task. The software could prioritise tools which are known to be appropriate for developing these skills, with the prioritisation of tools being achieved through a cross-comparison of the

vocabulary used to write outcomes (Centre for Outcomes-Based Education, 2007, p. 6) with the key words used to describe the task for which tools are known to be useful for (Phoebe project, 2008). Furthermore, colour coding of learning outcomes could enable the designer to see at a glance the make up of outcomes in our outcomes view. A further refinement would be to represent the intended learning effort (time spent) on the activities, e.g. by varying the size of the activity icons. An example of a learning outcomes view visualised using these ideas is shown in Figure 3. This figure shows a representation of two activities, of which the 'Applying theory to practice' activity is intended to occupy the student for double the duration of the other activity, hence the radius of the icon is double the size. One of the learning outcomes is a 'cognitive' outcome, which has a green flag showing a 'C' at its top left point. The other is a 'knowledge and understanding' outcome, which has a red flag with showing a 'K' at its top left point.

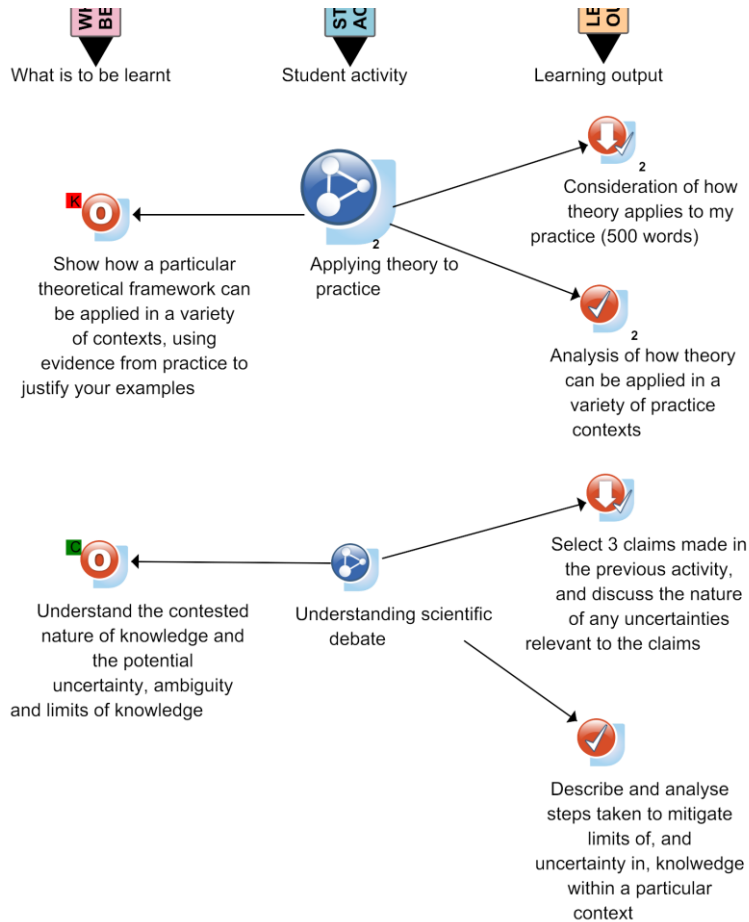


Figure 3: Learning outcomes view showing outcome types and activity durations

This representation should help the designer because it shows clearly how the learners' effort relates to different types of outcome.

## CONCLUSIONS

In this chapter we have reflected on the development of CompendiumLD, a tool for creating visual representations of learning designs. We have described the conditions in which CompendiumLD is likely to be applied and appreciated by users. These can be summarised as characteristics of the problem to which it is applied, and the characteristics of the user(s) making use of it, i.e.

- users are comfortable with a visual approach
- the design problem features many design choices (e.g. a free choice of tools, resources, teaching approach etc.).

We have discussed how Bertin's ideas on the semiology of graphics can be used to advance the visual representation of learning designs, and have presented an initial experiment to illustrate the approach. Further experiments of this type will help us move towards a visual language for learning designs.

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